CUT-RESISTANT ARTICLES OF ARAMID MICROFILAMENTS

The invention pertains to cut-resistant articles made of aromatic polyamide microfilaments.

It is known that cut-resistant articles can be made of aromatic polyamide (polyaramid) fibers. In DE 29713824 a protective glove has been described the lining of which comprises flexible aramid fiber. In WO 9721334 penetration-resistant compositions have been disclosed in which yarns of aramid fibers are bonded to a polymeric continuum. This material is primarily aimed at body armor for protection against ballistic projectiles, but it is also described that the compositions can be used against sharp objects, such as knives, in gloves, sleeves, shoes, and the like. Gloves made from poly(para-phenylene terephthalate) yarn (p-aramid yarn) are commercially available, for instance, under the name Twaron® Safety Gloves.

Although these articles, in particular gloves, are suitable in many cases, there is still a need for improvement. Such improvement includes a better resistance against stubbing and cutting by sharp objects, such as nails, knives, and the like, but also increase of wear comfort, freedom of movement, and enhanced suppleness are long sought improvements.

It has now been found that cut-resistant articles with improved properties in comparison to known articles can be obtained by using microfilaments of aromatic polyamide (polyaramid).
Aromatic polyamide microfilaments as such are known, for instance from EP 241,681, wherein articles made of polyaramid microfilaments have been disclosed for use as ballistic protection structures. However, it is

unknown for articles made of polyaramid microfilaments to have substantially improved properties with respect to cut resistance and wear comfort.

The present invention therefore pertains to articles made from polyaramid microfilaments, and in particular to gloves, sleeves, and cut-protective garments in general. Woven fabrics, knits, or needle felts may be applied. A plurality of layers may be used to improve the performance, and if required, additional layers of a different material, for instance, metallized materials for additional heat protection, may be added.

The aromatic polyamide (polyaramid) may be any aromatic polyamide, such as obtained by the polymerization of an aromatic diamine and an aromatic di-acid chloride. More preferred are para-aromatic polyamides, and most preferred is poly(para-phenylene terephthalate) (PPD-T), which can be obtained from p-phenylenediamine and terephthaloyl chloride.

The aromatic polyamide is spun into microfilaments in a manner known in the art and the spun fiber can be used as endless filament yarn, stretch breaking yarn or, more preferably, as spun yarn based on staple fiber. The spun yarns of this invention can be made by any appropriate spinning processes, among which can be mentioned spinning processes, such as cotton, worsted, and woolen ring spinning systems, and open end spinning processes. If staple fibers are used for the manufacture of cut-resistant articles, preferably staple fibers with a length between 38 and 100 mm are used.

The microfilaments have a titer of at least 1.3 dtex (1.3×10^{-4} g/m) or smaller, preferably equal to or less than 1.0 dtex (10^{-4} g/m).

The cut-resistant articles of this invention such as gloves are manufactured, for instance, by knitting the yarn obtained from the aromatic polyamide microfilaments.

The yarns according to the present invention are more cut-resistant than comparative standard yarns with titers above 1.3 dtex (1.3×10^{-4} g/m). If gloves are made of these microfilaments, the gloves have superior wear comfort in comparison with gloves with standard filaments. The gloves made with microfilaments are much more supple and therefore give the user a high wearing comfort. These gloves therefore are also eminently suitable for performing subtle tasks.

The invention is further illustrated by the following experiments

Knitted samples made out of standard spun yarn and microfilament spun yarn were compared:

The cut resistance was established according to DIN EN 388:

	standard	micro-filament	standard	micro-filament	standard	micro-filament
filament titer (dtex)	1.7	0.93	1.7	0.93	1.7	0.93
staple fiber titer	Nm 28/2	Nm 28/2	2 x Nm 50/2	2 x Nm 80/2	2 x Nm 80/2	2 x Nm 50/2
plied yarn twist	α 120	α 120	α 100	α 100	α 100	α 100
density (horizontal cm^{-1} x vertical cm^{-1})	7 x 11	7 x 11	7 x 10	7 x 10	7 x 9.5	7 x 9.5
smallest index	6.5	9.1	3.3	3.6	2.1	5.7
performance level	3	3	2	2	1	3

Conclusion: The smallest index is larger for the microfilament yarn than for the standard yarn. The performance was always better for the microfilament yarn. Where the performance has the same number according to DIN EN 388, the standard sample is at the lower end and the microfilament sample at the higher end of the performance level.

Moreover, the knitted fabrics based on microfilaments are much softer and have a finer "hand" than comparable fabrics based on standard fibers with a count of 1.7 dtex.

In addition, the mechanical properties of spun yarns based on microfilament and standard fibers have been investigated. These spun yarns were produced according to the cotton ring spinning process. As can be seen from the tables below, the strength is considerably improved for the microfilament spun yarns. We believe that the higher tensile strength of the microfilament spun yarns is responsible for the improved cut resistance of fabrics made from microfilaments. The flexibility was determined according to DIN 53362. The flexibility, denoted as the bending stiffness, is a measure for the "grip" and the suppleness of the gloves.

	standard	micro-filament	standard	micro-filament
filament titer (dtex)	1.7	0.93	1.7	0.93
staple fiber titer	Nm 50/2	Nm 50/2	Nm 50/2	Nm 50/2
yarn twist	α 100	α 100	α 120	α 120
strength (N)	39.47	43.55	39.72	42.97
bending stiffness (cN/cm^2)	56.89	9.90	17.60	13.60

	standard	micro-filament	standard	micro-filament
filament titer (dtex)	1.7	0.93	1.7	0.93
staple fiber titer	Nm 80/2	Nm 80/2	Nm 80/2	Nm 80/2
yarn twist	α 100	α 100	α 120	α 120
strength (N)	20.96	21.52	19.99	21.03
bending stiffness (cN/cm^2)	12.47	5.52	12.94	4.37

Conclusion: the strength is considerably improved for microfilament staple fibers, whereas in all cases improved bending stiffness was found for gloves made from microfilaments.